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ABSTRACT

The purpose of this study was to show that societal problems such as energy and pollution should be included as a central and underlying theme in a college chemistry course. A questionnaire was administered to 156 college students in science and technology to determine whether the students felt that they would be more highly motivated in chemistry if the subject matter frequently involved the topics of energy and pollution. Using Chi-square and t-test statistics, it was shown that students of all ages in the study considered energy and pollution to be the most critical of all societal problems included in the questionnaire. Other results of the questionnaire showed that the students were interested in practical applications of chemical principles and that they preferred a laboratory with emphasis on both principles and applications. (MH)

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SOCIETAL FACTORS IN THE TEACHING OF CHEMISTRY

CORE MODULE

SOCIETAL FACTORS

by

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A PRACTICUM PRESENTED TO NOVA UNIVERSITY IN
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THE SOLUTION TO POLLUTION

The solution to pollution ain't dilution anymore.
We have done filled up our country from shore to shore;
We have buried it in the ground and spread it all around,
The solution to pollution ain't dilution anymore.

Just go back to your old home place and take a look and see,
You won't find that nice clean stream where the fishes used to be,
You will find a lot of rotten garbage there in its place,
Oh my God, what a disgrace.

I took my boy for a walk one sunny afternoon,
He looked up in the darkened sky and said, "Daddy what a pretty moon!
I thought is this the kind world we will leave our children in,
Oh my God, where will it end.

Where do we lay the blame for all this terrible mess,
Not the President, the Senator, or any of the rest,
All of us are responsible we yet may lose the race,
Oh my God, what a disgrace.

The solution to pollution ain't dilution anymore,
We have done filled up our country from shore to shore;
We have buried it in the ground and dumped it in the sea,
The solution to pollution depends on you and me.

(Cheek, 1973)

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INTRODUCTION

Context of the Problem

Many college instructors and professors of chemistry evidently feel that to include such topics as energy, pollution, and other societal factors in their regular chemistry courses is unwarranted and/or unprofessional. They feel that such topics just have no place in a "good solid college chemistry course" and should be either relegated to other fields or learned at home from "T.V.". There appears to be a belief by some instructors that if such topics as energy and pollution were included regularly in the chemistry course, the result would be a "watering down" of course content. (West, 1971)

In the opinion of the author, there has been, in chemical education, too much separation between the classroom and the real world. The effect of this is that many chemistry students (and teachers) do not recognize or realize that chemistry is a part of everyday happenings. We as human beings eat chemicals, breathe chemicals, bathe in chemicals, and sleep on chemical beds. The workings of our bodies involve a host of chemical reactions. For students living in a chemical world, the understanding of problems dealing with pollution and energy are necessary for survival. It is believed that the inclusion of such topics in the teaching of college chemistry is a powerful motivator for students.

Yankelavich (1974) has shown a vast, sudden change in the attitudes of young people in this country since 1960. Educators must be constantly aware of, and should anticipate, the attitudinal changes of the young people (as well as older) to determine what factors should be used as motivators in education.

Cook (1971) states the case of "whether chemistry instruction should reflect social concern" when he summarizes the AAAS "Symposium on chemistry and social change."

> "In that group, individuals with widely varying professional objectives and at widely separated levels of the community of chemists pecking order found common ground in belief that chemistry instruction at all levels is too sterile, too ingrown, too self-gratifying, and too isolated from the society which relies heavily on the science it nurtures. We concurred that chemistry is one of the most dramatic subjects of all curricula, that it should be relevant, humanistic, and better understood by those who are exposed to it in the classroom.
>
> Other groups considered the structure of chemistry, its content for those who sought a profession in chemistry, graduate programs, and international aspects. You may be surprised to learn that each of those groups drafted recommendations that spoke to the importance of chemistry instruction being sensitive to societal needs and more relevant to preprofessional students."

Still, many people who teach college chemistry do not feel there is a place for societal factors in the teaching of college chemistry. The author feels that there is, and this paper will show some reasons why the topics such as energy and pollution should be used in the teaching of chemistry today.

Statement of the Problem

This study was made to show the importance and the possible impact of the societal factors, energy and pollution, on the teaching of college chemistry. This study was made to answer the following specific questions:

(1) Is there a significant difference in how various Central Piedmont Community College (CPCC) students of different ages feel about energy and pollution?

(2) Do students (and some teachers) feel that pollution and energy problems are more critical than other societal problems?

(3) Do students feel that societal problems should be included in a chemistry course?

Review of Literature

Pollution, as defined in the modern sense, probably began in the English towns during the industrial revolution. According to Ridgeway (1971), the idea of environmental controls and almost all our modern programs for controlling pollution began with the premise that controlling pollution was, and is now, essential for industrial growth. Thus, environmental pollution as we now know it, began about one-hundred and fifty years ago. Today much of the pollution control technology is little changed since the mid-nineteenth century, and there are still many towns in the United States that treat sewage by the same methods as recommended in 1900. (Ridgeway, 1971)

The National Community Water Supply Study, (Pettyjohn, 1970), illustrates the inadequacies of our modern environmental systems. The major findings from the study are:

QUALITY OF WATER BEING DELIVERED

- 36 percent of 2,600 individual tap water samples contained one or more bacteriological or chemical constituents exceeding the limits in the Public Health Service Drinking Water Standards.
- 9 percent of these samples contained bacterial contamination at the consumer's tap evidencing potentially dangerous quality.
- 30 percent of these samples exceeded at least one of the chemical limits indicating waters of inferior quality.
- 11 percent of the samples drawn from 94 systems using surface waters as a source of supply exceeded the recommended organic chemical limit of 200 parts per billion.

STATUS OF PHYSICAL FACILITIES

- 56 percent of the systems evidenced physical deficiencies including poorly protected groundwater sources, inadequate disinfection capacity, inadequate clarification capacity, and/or inadequate system pressure.
- In the eight metropolitan areas studied, the arrangements for providing water service were archaic and inefficient. While a majority of the population was served by one or a few large systems, each metropolitan area also contained small inefficient systems.

OPERATORS' QUALIFICATIONS

- 77 percent of the plant operators were inadequately trained in fundamental water microbiology; and 46 percent were deficient in chemistry relating to their plant operation.

STATUS OF COMMUNITY PROGRAMS

- The vast majority of systems were unprotected by cross-connection control programs, plumbing inspection programs on new construction, or continuing surveillance programs.

STATUS OF STATE INSPECTION AND TECHNICAL ASSISTANCE PROGRAMS

- 79 percent of the systems were not inspected by State or County authorities in 1968, the last full calendar year prior to the study. In 50 percent of the cases, plant officials did not remember when, if ever, a state or local health department had last surveyed the supply.
- An insufficient number of bacteriological samples were analyzed for 85 percent of the water systems-and 69 percent of the systems did not even analyze half of the numbers required by the PHS Drinking Water Standards.

Pollution reforms of the last ten to twenty years have done little to slow the rate of pollution either nationally or locally. In cases where the local organizations were making progress in controlling pollution, local political forces interfered. For example, in Charlotte and Mecklenburg County, N.C., a Citizens Advisory Committee was appointed by the local Health Department for the purpose of advising the health department and the industries involved of violations of the water pollution regulations. The committee made corrective recommendations to both the health department and the violating industries. (The author was a member of that committee). The committee was doing an excellent job by placing the violators under pressure which resulted in much of an improved water control system. An example of the committee's work is shown in the minutes of a meeting in 1973.

"I have a letter here dated June 12 to the committee from Mr. Winfred Ervin, attorney for Mr. Lee. I will read it:

> "Subsequent to our appearance before your Committee on May 15, 1973, several contingencies have arisen as will relate to Mr. Lee's waste water pollution control, which unfortunately I am not at liberty to divulge. However, Mr. Lee has authorized me to notify the Advisory Committee in writing that he will, prior to December 31, 1973, either (1) bring himself within the regulations relating to waste water pollution, or (2) cease and desist from any operation which is in violation."

Then, suddenly, the members were informed by the Charlotte-Mecklenburg Health Department that the committee would no longer function due to some legal technicality. The letter informing the members of the committee's demise has been read several times by the author with little success in interpreting and/or understanding its contents.

This is just one example on the local level of the "politics of Ecology" that James Ridgeway cites in his book entitled Politics of Ecology.

Most experts agree that both energy and pollution problems arose as a result of overpopulation, and that these problems have become a dominant factor in world politics. Energy, in particular, has become a means of exerting international leverage; and energy problems have been the underlying factors in many international conflicts.

Energy is absolutely crucial for all peoples, especially students. Along with the exponential increases in world population, there has been an exponential increase in energy consumption and pollution production.

World population growth and United States energy production are summarized in the following graphs where both population growth and energy consumption are seen to rise slowly. Then suddenly, about the turn of the century, the rates of population increases and energy consumption became exponential.

FIGURE I

WORLD POPULATION GROWTH

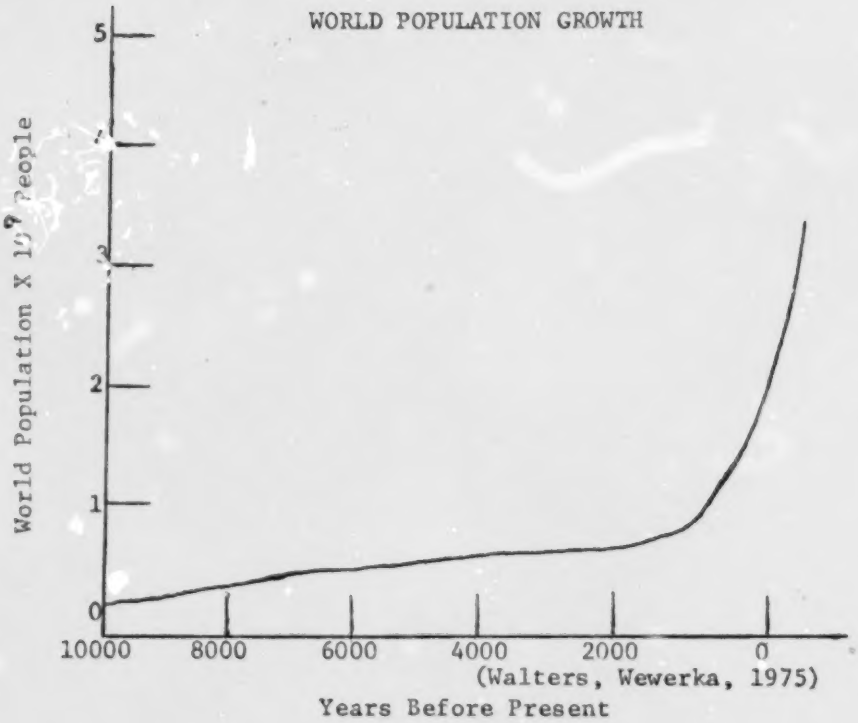


FIGURE 2

ENERGY PRODUCTION CURVE FOR THE U.S. SINCE 1860

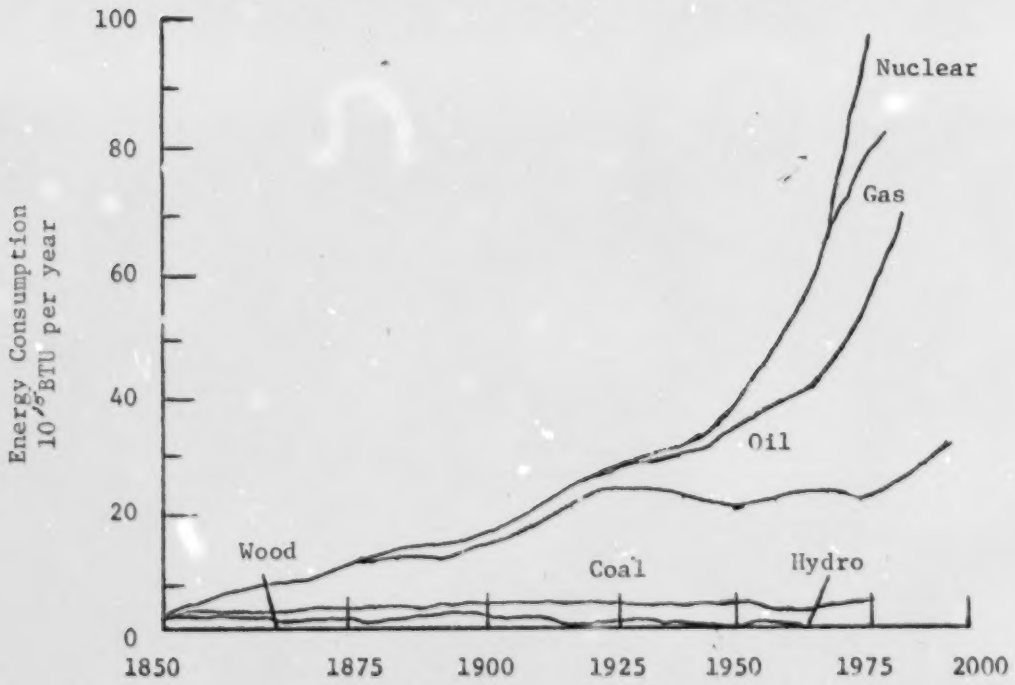


Figure 1 shows that about ten thousand years ago, the population was approximately 0.1 billion with a gradual increase to about 0.7 billion.....then the population explosion hit and we are still in the midst of it.

Energy sources and the consumption curve in the United States for the past one-hundred and fifty years is shown in Figure 2. In 1850, about all of our energy came from wood, but wood was later replaced by coal, petroleum, natural gas, hydroelectric and some nuclear fuel. For comparison, the United States energy sources today are shown in Table 1.

TABLE 1

SOURCES OF ENERGY IN UNITED STATES

Coal	20%	
Petroleum	45%	75% of the total
Natural gas	30%	
others	5%	

These shocking figures reveal that the current energy consumption rate for the highly technological United States is about ninety quadrillion (90×10^{15}) BTU per year. It is estimated that the doubling time for energy consumption in the United States is about twenty years. If this is true, the United States will be using over two-hundred quadrillion BTU per year by the year 2000.

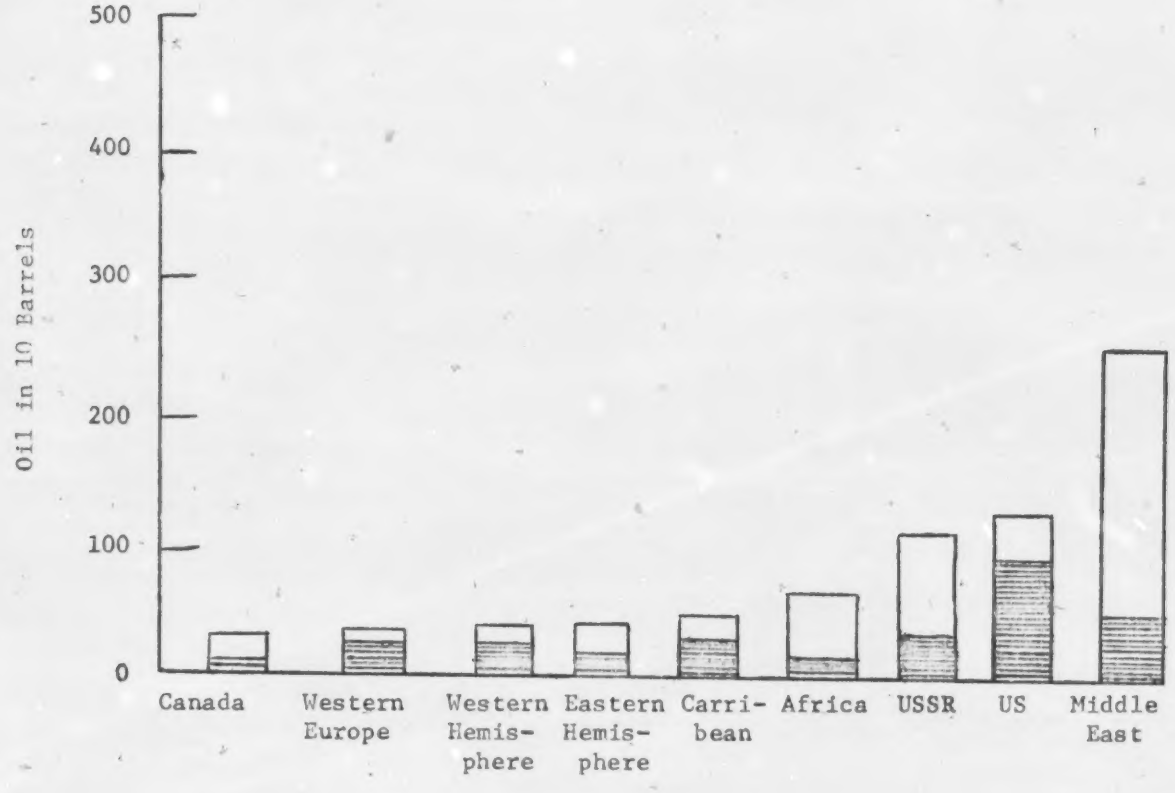
The most significant thing to the author is not the present energy consumption rate of ninety quadrillion BTU per year, but the expected doubling time of only twenty years for energy consumption. This is indeed alarming. (Walther, Wewerka, 1975).

The exponential population growth is parallelled by increase in the standard of living resulting in a major increase in energy consumption - much of which is used up in such things as television viewing and air-conditioned homes and commercial buildings.

An obvious question at this point is where is all this energy going to come from? Figure 3 shows the total oil production history of the world per year since the year 1900 and also the estimated amount through the year 2000.

FIGURE 3

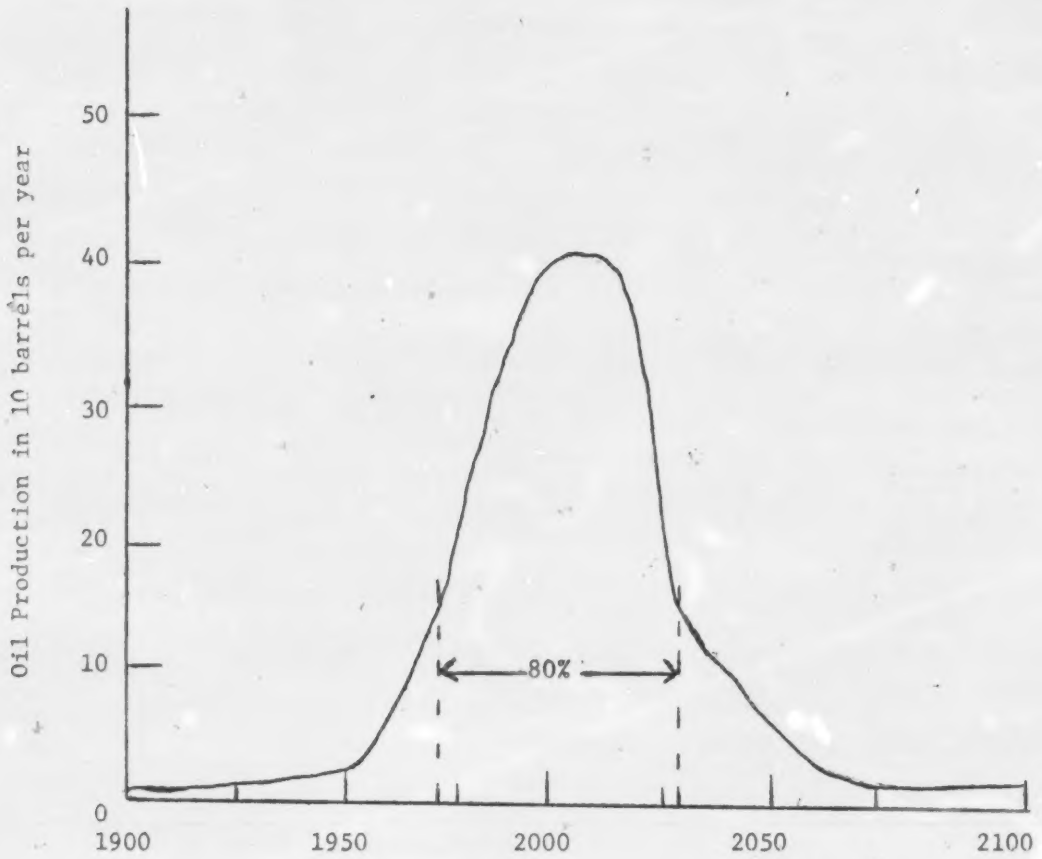
LOCATION AND QUANTITY OF PETROLEUM AROUND THE WORLD (the shaded area indicates the amount used from 1859-1971. The other portion of the graph indicates the amount unused). (Walters, Wewerka, 1975)



The significance of this graph in terms of the expected doubling time of energy consumption is that over eighty percent of the known deposits will be depleted by the year 2030. This is illustrated in Figure 4.

FIGURE 4

TOTAL OIL PRODUCTION HISTORY OF THE WORLD



The maximum production in the United States will be around the year 1880-1885 while on a worldwide basis, maximum production will occur in the year 2000. Another

alarming estimate is that if the world's petroleum reserves were doubled, the world's petroleum reserves would be extended by two or three decades!

Of major concern to the United States and the other highly technological countries is the location and quantity of the petroleum. Figure 3 shows the amount of oil in barrels versus location of the oil. Obviously, the United States has used up a large portion of its reserves. By far, the greatest fraction of the world's remaining reserves are located in the Middle East.

Table 2 shows the United States energy reserves and consumption rates for each type of fuel. It is estimated that the United States petroleum reserves will be depleted in about thirty years, during the life-time of most people alive today.

TABLE 2

UNITED STATES ENERGY RESERVES AND CONSUMPTION RATES

Fuel	Probable reserves	Consumption Rate		Years of reserves
		1970	2000	
Oil	882 (@ 42% recovery)	30	30	30
Gas	945 (@ 82% recovery)	22	20	47
Coal	30,200 (@ 50% recovery)	13	35	2300
Uranium -235	900	0.229	75	36
Plutonium-239	115,000	0	..	4500
Geothermal				
wet and dry steam		0.6		
dry rock steam		10		?
Solar	0.03 $mi^{-2}yr^{-1}$			10
Fusion of deuterium	1.2 X 10^{13}	0	0	virtually unlimited

What about other energy sources for the future, such as nuclear fission, geothermal, solar, and nuclear fusion? Many of these remain to be developed and several unforeseen problems have surfaced with the development of nuclear fission energy.

Table 3 shows the main future energy sources available along with their advantages and disadvantages.

TABLE 3

ADVANTAGES AND DISADVANTAGES OF ENERGY SOURCES

SOURCE	ADVANTAGES	DISADVANTAGES
^{235}U fission	Present technology exists Less polluting than fossil fuels	Small reserves Radioactive wastes Hazards involving radioactive species
Breeder reactors	Technology almost ready Less polluting than fossil fuels Relatively large reserves	Radioactive wastes Radioactive and fissionable materials hazards
Geothermal	Relatively clean Few hazards Relatively simple technology	Reserves uncertain Possible tectonic effects Air pollution Some noise pollution Low use efficiency
Solar	Unlimited reserves Very clean Reduction of thermal pollution Conceptually simple Adaptable to individual	Very diffuse, difficult to collect Technology not ready for large scale use Distribution and storage problems Geographical limitation and restrictions
Fusion	Clean (?) Unlimited reserves	Technology will not be available for many (50) years Others (?)

Problems that have arisen regarding nuclear fission energy are the enormous cost, a feasible method for disposal or storage of radioactive wastes, and the development of necessary technology of the "breeder reactor". One interesting and unexpected problem has been acceptance by the public. The lack of public acceptance of nuclear

power is summed up by Dr. Dixy L. Ray. She notes that:

> "in the nuclear field . . . we are mesmerized by minuscule risks, taken up in a state of near hysteria in some quarters about 'what if,' and scare scenarios of various kinds. We are letting time go by and not making use of this one enormously practical, economic technology developed in this country that we have available to us."

This could, however, be an oversimplification of the problem.

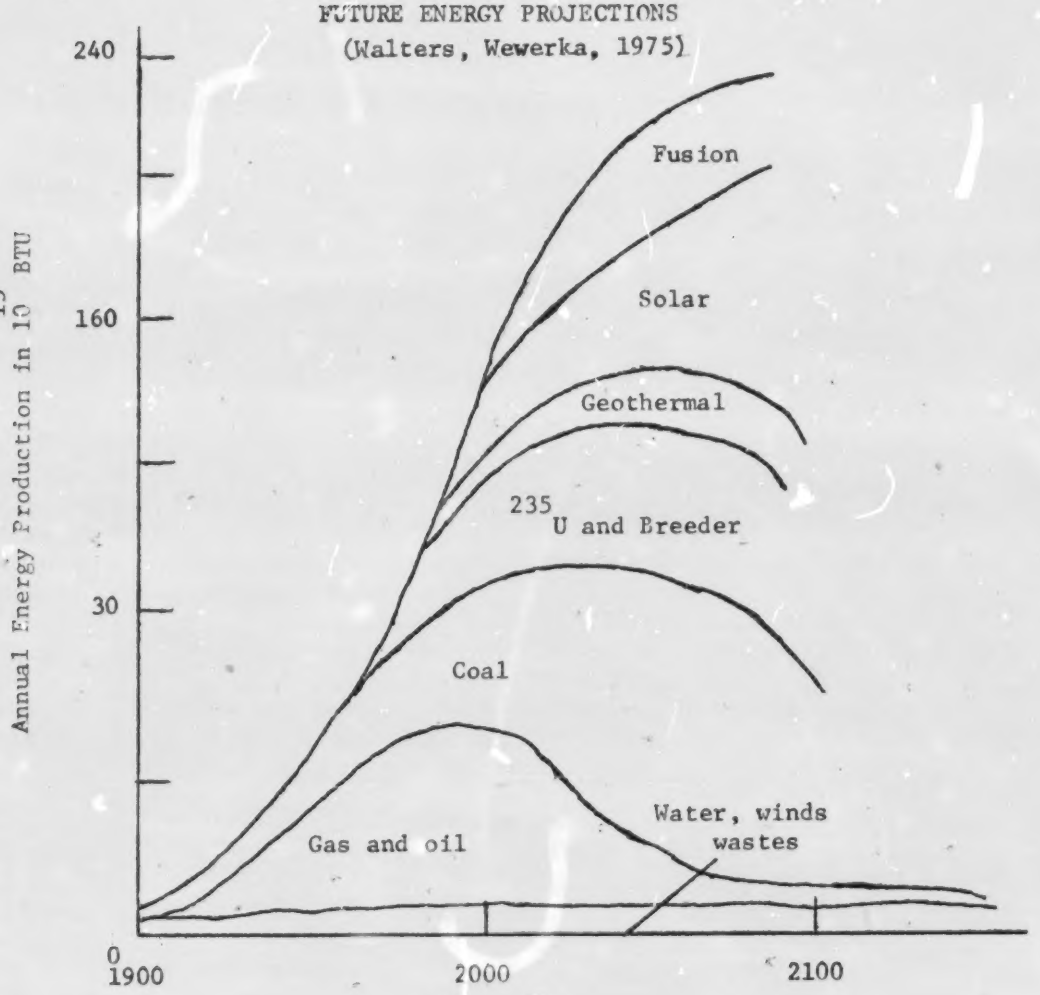
The increased emphasis on the use of solar energy as a possible partial replacement for petroleum is illustrated by the N.S.F. grant of $186,000 to the MIT energy lab to study the feasibility of using solar energy to conserve fuel in large urban buildings. This particular project is to be located atop the Citicorp Center in Manhattan, New York.

> The National Science Foundation has awarded MIT's Energy Laboratory $186,000 for the 12-month program. NSF sources told INDUSTRIAL RESEARCH that the new solar dehumidifier system will be compared side-by-side with a conventionally-powered unit and is expected to handle much of the dehumidifying needs for the upper 25 floors.
>
> Preliminary estimates suggest the solar system will achieve a 5% energy savings-small only because the collector area is small compared to total building surface area.

A projection of future energy sources is shown in Figure 5 which depicts the annual BTU versus years for various energy sources. According to this projection, coal will have replaced petroleum as the main source of energy by the year 2000. By the year 2100, the main sources of fuel will be nuclear fission, solar energy, geothermal energy, and nuclear fusion energy. The most promising, unlimited source of energy is thought to be nuclear fusion energy.

FIGURE 5

FUTURE ENERGY PROJECTIONS
(Walters, Wewerka, 1975)



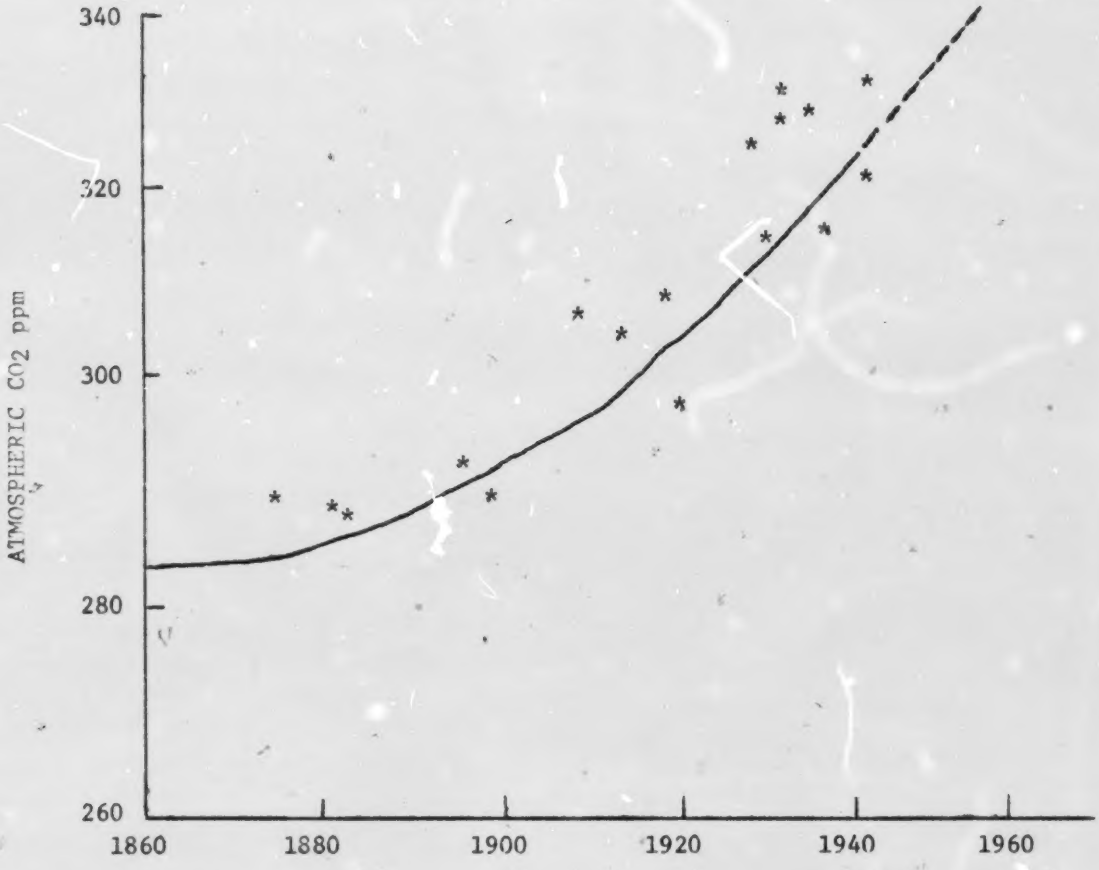
Along with man's technological progress, population growth and incurred energy consumption comes the problem of pollution. Where there are people, there is pollution. Where there is energy being expended, there is pollution being produced.

About ninety-five percent of all man's energy today comes from chemical reactions. One of the main products of these energy producing reactions is carbon dioxide (CO_2). If we look at the concentration of CO_2 in parts per million (ppm) since the year

1860, we see an exponential increase in CO_2. Concentration with time.

FIGURE 6

CONCENTRATION OF CO_2 IN ATMOSPHERE SINCE 1860
(Stoker, Spencer, 1972)

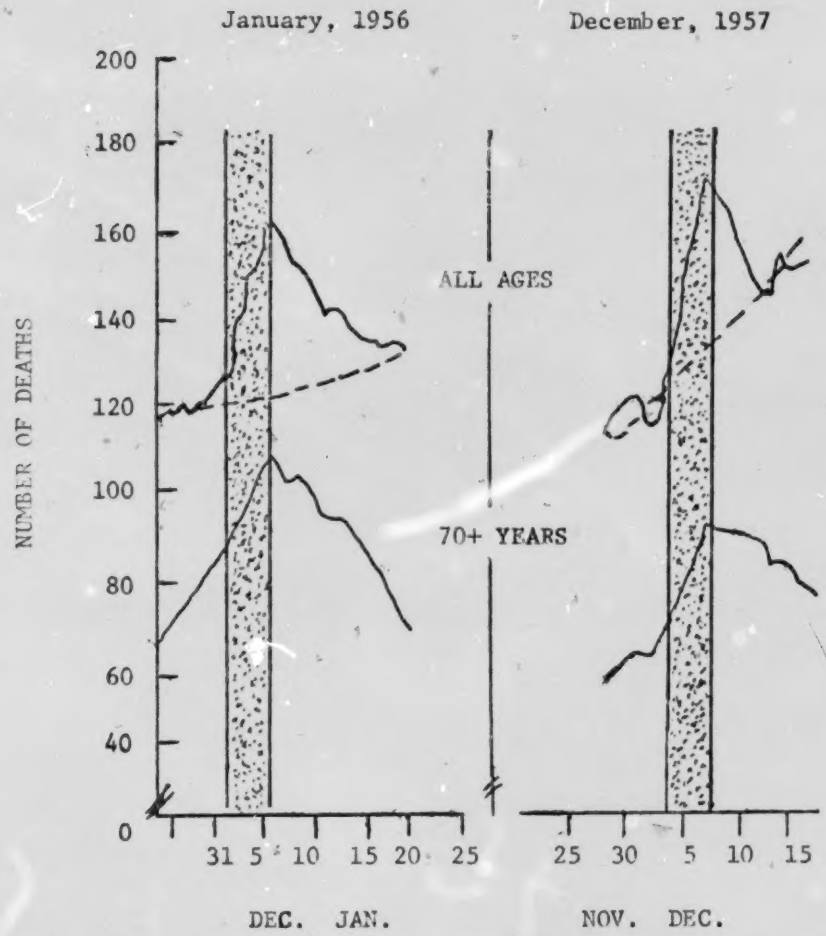


This increased concentration of CO_2 in the atmosphere is the result of man's increased burning of fossil fuels and greater agricultural activities of man. The concentration of CO_2 in the atmosphere is taken by some people as an index of the amount of pollution that exists. The reason for this is that the amount of CO_2 is a measure of the degree of energy producing reactions that are taking place. Although

CO_2 is not in itself a severe pollutant, the effects of producing larger and larger amounts over a long period of time may have a profound effect on the atmosphere, such as the so called greenhouse effect. An example of the direct effect of pollution is the number of deaths occurring during a smog episode in London in 1956 and 1957.

FIGURE 7

MORTALITY FIGURES IN LONDON
(Stoker & Spencer, 1972)



The long-term effects of pollution are not known, but one thing is for certain.....along with the population explosion, improved standard of living and the energy consumption explosion in our highly industrialized society comes the pollution explosion. This is well illustrated by the following graph and tables. First, consider the element mercury. Six million pounds of mercury are produced each year in the United States. Where does all this mercury end up?

TABLE 4

MERCURY LEVEL CONSUMPTION IN THE U.S. IN 1969
(Stoker and Spencer, 1972)

AREA OF USE	
Chlor-alkali industry	1,572,000
Electrical apparatus	1,382,000
Paint	739,000
Instrumentation	391,000
Catalysts	221,000
Dental preparations	209,000
Agriculture	204,000
General laboratory use	126,000
Pharmaceuticals	52,000
Pulp and paper making	42,000
Amalgamation	15,000
Others	1,082,000
TOTAL	6,035,000

TABLE 5

MERCURY LEVEL IN FRESHWATER FISH
(Stoker and Spencer, 1972)

FISH	MERCURY LEVEL (ppm)
Walleye pike	1.4 to 3.57
Sucker	0.88
Northern pike	0.64
White bass	0.53 to 0.80
Channel catfish	0.32 to 1.80
Coho salmon	0.24 to 0.96
Carp	0.08 to 0.28

A portion of the mercury in the lower plant and animals is translocated into the food that man eats. This is shown in Table 6.

TABLE 6

CONCENTRATION OF MERCURY LEVEL (ppm) IN MEAT
(Spencer and Leager, 1972)

MEAT PRODUCT (RAW)	Swedish	Danish
Pork chops	0.030	0.003
Beef	0.012	0.003
Bacon	0.018	0.004
Pig liver	0.060	0.009
Ox liver	0.016	0.005

The occurrence of mercury poisoning in man is a well-documented fact and some of these occurrences are recorded in Table 7. Most of the poisoning resulted from eating mercury-contaminated fish or from seeds that had been treated with mercury compounds.

TABLE 7

SOME MAJOR MERCURY POISONING

LOCATION	YEAR	RESULTS
Minamata Bay, Japan	1953-60	111 dead or seriously injured
Iraq	1961	35 dead, 321 injured
West Pakistan	1963	4 dead, 34 injured
Quatemala	1966	20 dead, 45 injured
Nigata, Japan	1968	5 dead, 25 injured

The element lead is another heavy metal that is very toxic to man, and the enormous widespread use of this metal is demonstrated by the annual production and distribution of lead in the environment.

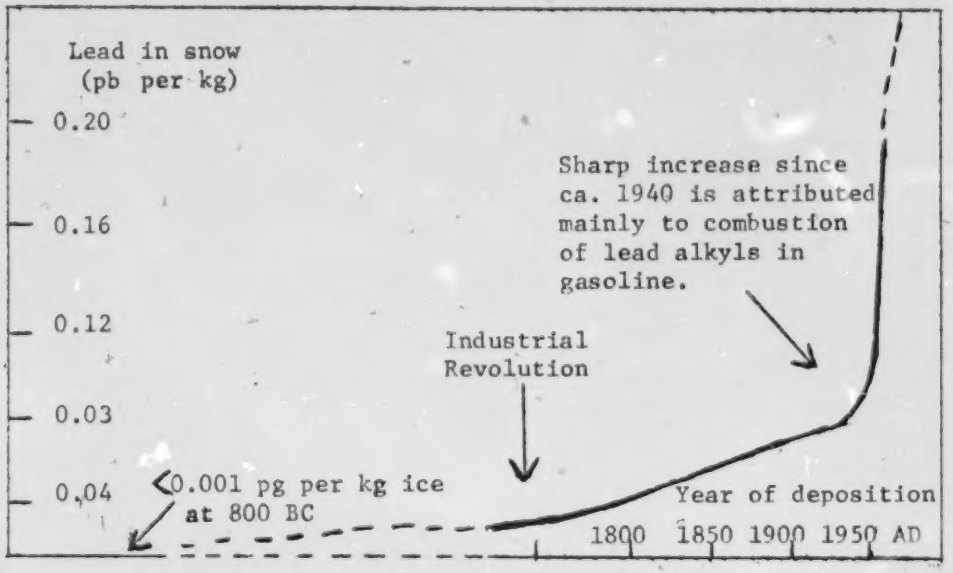
TABLE 8

ANNUAL PRODUCTION OF Pb IN UNITED STATES (1969)

APPLICATION	TONS USED	PERCENTAGE OF TOTAL USED
Storage batteries	582,546	43.1
Metal products	354,411	26.2
Chemicals	271,730	20.1
Pigments	101,185	7.5
Miscellaneous	42,103	3.1
TOTAL	1,351,975	100.0

FIGURE 8

Pb CONTENT IN THE GREENLAND ICE
(Stoker and Seager, 1972)



Similar graphs and tables could be tabulated and reproduced on many other compounds and elements such as DDT, parathion, and detergents which are being produced and dispensed in the environment at an alarming rate. The facts compiled on the increase in chemical pollution by man point up a most critical problem to all people. This problem should be of special interest to the chemistry student!

Students are concious of the problem of pollution and rate it as one of the most critical problems in a survey by Yankelavich, (1974). This is shown in the following charts.

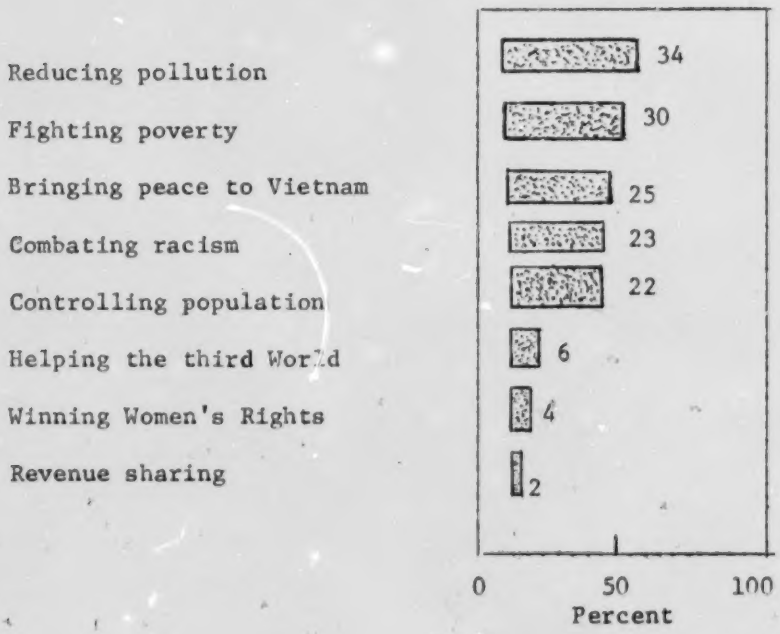
TABLE 9

SOCIAL PROBLEMS TO WHOSE SOLUTION THE STUDENT IS WILLING TO COMMIT A YEAR OR TWO OF HIS LIFE
(Yankelavich, 1974)

	TOTAL STUDENTS 1971 %
Reducing pollution	34
Fighting poverty	30
Bringing peace to Vietnam	25
Combating racism	23
Controlling population	22
Reducing hard drug addiction	19
Reforming the political institutions	14
Changing the social system	14
Combating crime	13
Legalizing abortions	13
Aid to higher education	12
Reforming the judicial system	11
Welfare reform	11
Legalizing marijuana	9
Consumers' rights	8
Curbing inflation	8
Bringing peace to the Middle East	7
Limiting the arms race	6
Helping the third world	6
Winning women's rights	4
Revenue sharing	2

A plot of the more important social problems are shown in Figure 9. (Taken from the data in Table 9).

FIGURE 9
GRAPH OF SOCIAL PROBLEMS



These data well illustrate that most students felt that pollution was a very critical problem in this country in 1971.

Hypothesis

It is believed that chemistry students will be more highly motivated in chemistry if the subject matter being taught frequently involves the topics of pollution and energy. To support this general belief, the following specific and measurable hypotheses are stated:

Hypothesis A:

The age of the Central Piedmont Community College student is not a significant factor in how Central Piedmont Community College

students feel about the importance of energy and pollution.

Hypothesis B:

There is a significant difference in how Central Piedmont Community College students feel about energy and pollution as compared with other societal problems.

Variables

Hypothesis A:

Independent Variable - Age
Dependent Variable - Feeling

Hypothesis B:

Independent Variable - Societal problem of energy - pollution and other societal problems.
Dependent Variable - Feeling

Operational Definitions of the Variables

(1) The feelings of students toward the problems of energy and pollution were determined by a questionnaire determining the rating of these problems along with other societal problems. (See appendix).

(2) Energy and pollution problems are defined in a general way.

Energy - all forms of energy consumed including solar, all the fossil fuels, nuclear and others including all kinds of food.

Pollution - all forms of pollution including noise, air, water, soil, chemical biological and any others (including educational).

(3) Other societal problems include such problems as economy, political corruptions, food supply, drugs, overpopulation, civil rights, and others. (See questions in appendix).

Rationale for the Hypothesis

The main purpose of this study is to show that societal problems such as energy and pollution should be included as a central and underlying theme in a chemistry course. This conclusion is based on the beliefs that students need to be aware of these problems for the survival of society, and that students will be motivated by the use of these real and relevant topics in their studies. The problems of energy and pollution are closely related to the lives and interests of students of all ages. They most certainly are a key part of a modern situation as opposed to a classical one. Practically all of our students have experienced the gasoline lines of the year 1974, and this experience made a lasting impression. The problems of energy and pollution will be factors in the future needs of the chemistry student, and therefore, he/she will be motivated by the study of these factors. Energy-pollution are truly important problems for all people and indeed for the survival of mankind.

Significance of the Study

A basic problem for all educators is that of increasing student interest in a given learning situation. This problem may be compounded when the learning activity becomes more demanding, as is the case in most chemistry courses. The chemistry teacher has a tremendous task of motivating and, thus, needs to utilize as many "attention getting" devices as possible.

Experience in the teaching of chemistry has shown that a large percentage of the chemistry educators are so engrossed in the teaching of the classical laws and principles that the student may not realize that the subject has any relevancy in the modern world. Many students take chemistry courses solely for the purpose of

credit and/or the fulfillment of a graduation requirement without once relating the subject matter to a real life problem or situation. As an example, the author was once asked in all sincerity by a student in a general chemistry class, "Is this the same kind of Algebra that we learned in the math class?" Many times we as teachers fail to realize the limited experiences of our students, and we expect them to consolidate various learning activities when, in fact, they are unprepared to do so.

This study should bring about a change in the attitude (the author's attitude has been altered) of some chemistry instructors concerning the interest of their students. This change in attitude, in turn, may cause the chemistry instructors to include more relevant topics in their chemistry courses, resulting in a better informed chemistry student who can function more successfully in a modern society. Copies of this study will be widely distributed among the faculty at Central Piedmont Community College, University of North Carolina at Charlotte, and other local community colleges. It is hoped that this study will be used in one of the educational publications.

METHOD SECTION

A large portion of the one-hundred and fifty-six subjects that responded to the questionnaire came from students enrolled in chemistry and biology classes at Central Piedmont Community College. (Seventy percent) The remaining subjects questioned were enrolled in other college transfer courses and a few came from the trade and technical areas. The average age of these questioned was twenty-six years old, which is slightly lower than the over-all average age of the Central Piedmont Community College students. An attempt was made to select students from all areas of college transfer which constitute the major sources of chemistry students at Central Piedmont Community College. This selection was designed to obtain the opinion of subjects outside the areas of science and chemistry as well as within those areas.

The following table shows the average grade completed for each age group.

TABLE 10

AVERAGE EDUCATIONAL LEVEL OF SUBJECTS

AGE GROUPS	AVERAGE GRADE COMPLETED
15 - 20	12.6
20 - 24	13.5
25 - 30	14.4
31 - 35	14.28
36 - 40	16.6
40 -	17.0
OVER-ALL NUMBER AVERAGE =	13.8

The over-all average grade of the group was 13.8 years, and, as expected, there was a higher average grade completion for the older age groups.

Tasks

This study included the completion of the following major tasks:

(1) Writing of a questionnaire

(2) Administration of the questionnaire

(3) Summary of the data

(4) Treatment of the data

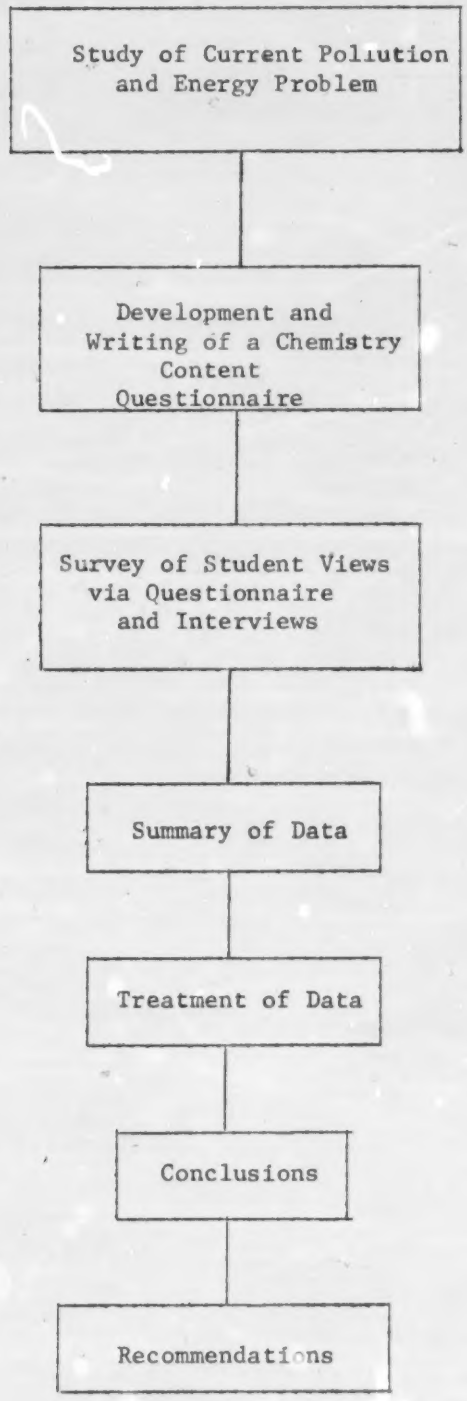
Procedures

The questionnaires were administered by various instructors in their classes at Central Piedmont Community College. Specific instruction concerning the attitudes toward energy and pollution were specifically defined by the person administering the questionnaire. The data were completed over a period of two months starting in the Spring Quarter and ending the first month of the Summer Quarter, 1975. The data were summarized and treated. Several possible statistical tests were considered and used before deciding upon the two statistical tests that were finally selected. A flow diagram for the study is included: (See following page for flow diagram for study).

Data Analysis

The hypothesis presented in an earlier portion of this paper was tested statistically using a two by two chi-square and a two by six chi-square to see if there was any relationship between the age of the subjects and the way the subjects felt about energy and pollution. To determine if there was a significant difference between the way all subjects felt about energy and pollution compared with all other

FLOW DIAGRAM FOR STUDY


Study of Current Pollution and Energy Problem
Development and Writing of a Chemistry Content Questionnaire
Survey of Student Views via Questionnaire and Interviews
Summary of Data
Treatment of Data
Conclusions
Recommendations

societal problems, the t-test was run on the difference between the mean rating values for energy and pollution and the mean rating values for all other societal problems.

To yield a group with a distinct and definite difference in their rating (one with a high and a low rating for energy and pollution), a two by two chi-square was run in which all of the ratings of a four on the one to eight rating scale were thrown out. The group was further divided into two age groups with fifteen to twenty-five years as the "young" group and twenty-six to fifty years as the "old" group. This yielded a two by two chi-square in which there was a distinct high and low rating with a distinct young and old age grouping. The grouping of ages was done in a way to obtain old and young groups of approximately the same number and with an age distribution similar to that of the normal population of Central Piedmont. (The over-all average age of the male student is twenty-nine and the over-all average age of the female student is thirty-one. The average in the college trarsfer area is not known and is probably lower than the over-all student average).

RESULTS

The results support Hypothesis A that there is no significant difference between the way students of different ages at Central Piedmont Community College feel about energy and pollution. The results also support Hypothesis B that there is a significant difference in how students feel about energy and pollution as compared with the other societal problems.

The chi-square values for both age groupings yielded results that were not significant. The chi-square values were 0.125 and 0.249 for the 2 X 6 and the 2 X 2, respectively. The data is shown in Table 11. (Best, 1959)

TABLE 11

CHI-SQUARE DATA FOR 2 X 2

	R_{1-3}	R_{5-8}
15 - 25 years	111	46
26 - 50 years	99	36

R_{1-3} - the number of subjects that rated energy and pollution 1,2, or 3 on the rating scale of 1 - 8. (1 being the most critical problem).

R_{5-8} - the number of subjects that rated energy and pollution 5, 6, 7, or 8 on the rating scale of 1 - 8. (1 being the most critical problem).

(Tuckman, 1972)

$\chi^2 = 0.249$

Again, the results indicate that there is no significant difference in how students of different ages at Central Piedmont Community College feel about pollution and energy. As is shown later, subject of all ages consider energy and pollution to be a most critical problem.

The t-test was used to determine if the mean rating values of energy and pollution were significantly different from the mean rating values of the other societal problems considered in the study. The result of the calculations gave a t-test value of 54.3 which is much greater than the table values (critical values) of 1.960. (Tuckman, 1972) Thus, there is a significant difference between the mean rated values of energy and pollution and the other societal problems included in the study. The data is summarized in Table 12. (Tuckman, 1972)
(Glass, Stanley, 1970)

TABLE 12

t-test Results

Mean rating value for energy and pollution.	3.16
Mean rating value for all other societal problems.	4.6
$t_{.05} = 54.3$ $54.3 \gg 1.960$	

A plot of the ratings for each of the factors taken from Section V in the questionnaire...."considering all of the problems facing society today, which do you consider the most critical? Please rate using the scale of 1 - 8, 1 being the most critical and 8 being the least critical!" This graph reinforces the results of the chi-square and t-test showing two things:

(1) There is not much variation in ratings within the same societal factors of pollution and energy, and

(2) Energy and pollution are seen to be higher on the graph than the other factors.

Please note the graph is plotted with the most important factors having the highest bar. (The values were obtained for each of the factors by subtracting their mean value from eight). Again, the results of this graph support the t-test and chi-square results which indicate that:

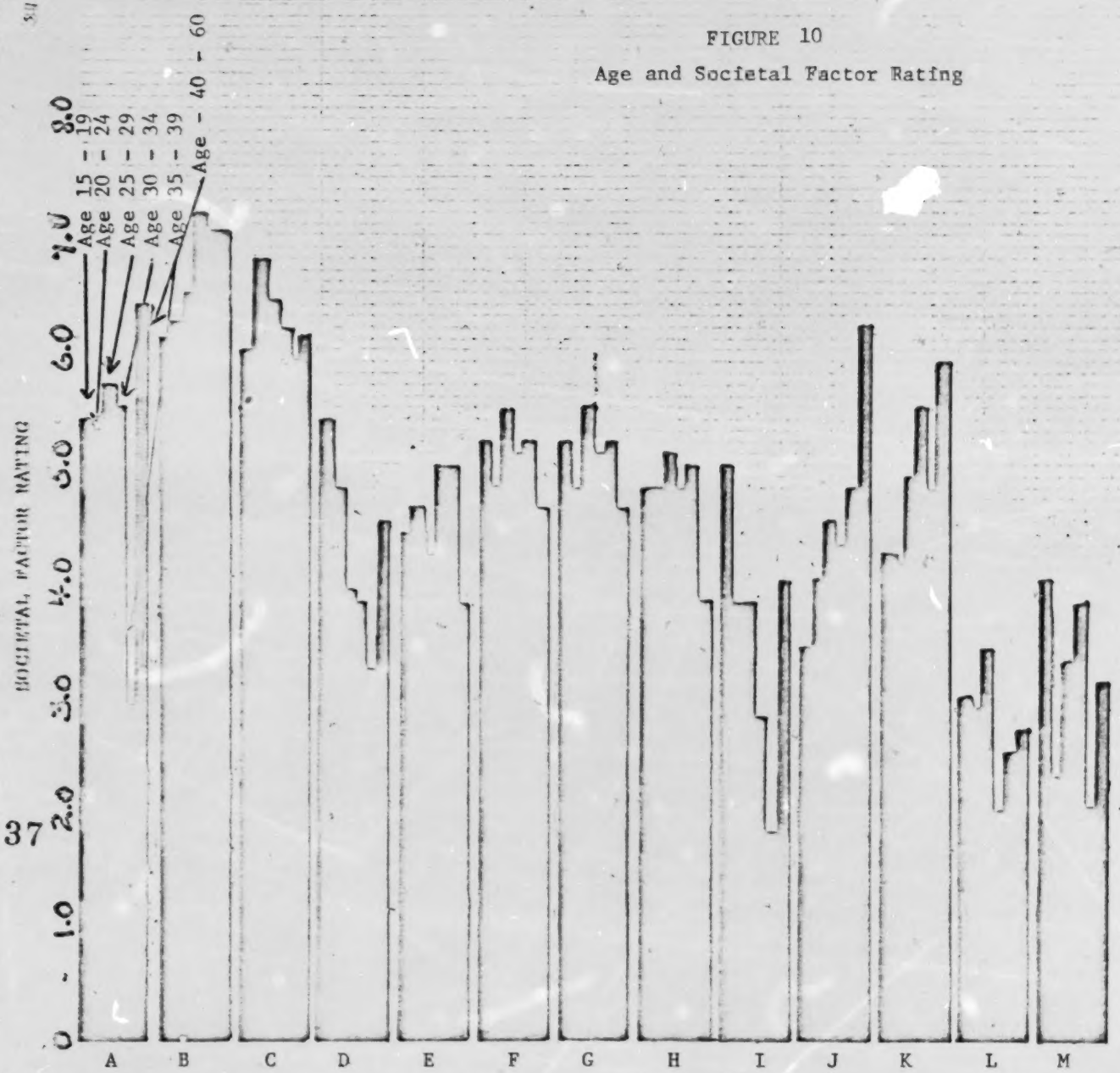
(1) All age groups feel that energy and pollution are important, and

(2) Most subjects feel that energy and pollution are the most critical of the problems facing society today.

(See Figure 10 on the next page, page 31).

FIGURE 10

Age and Societal Factor Rating

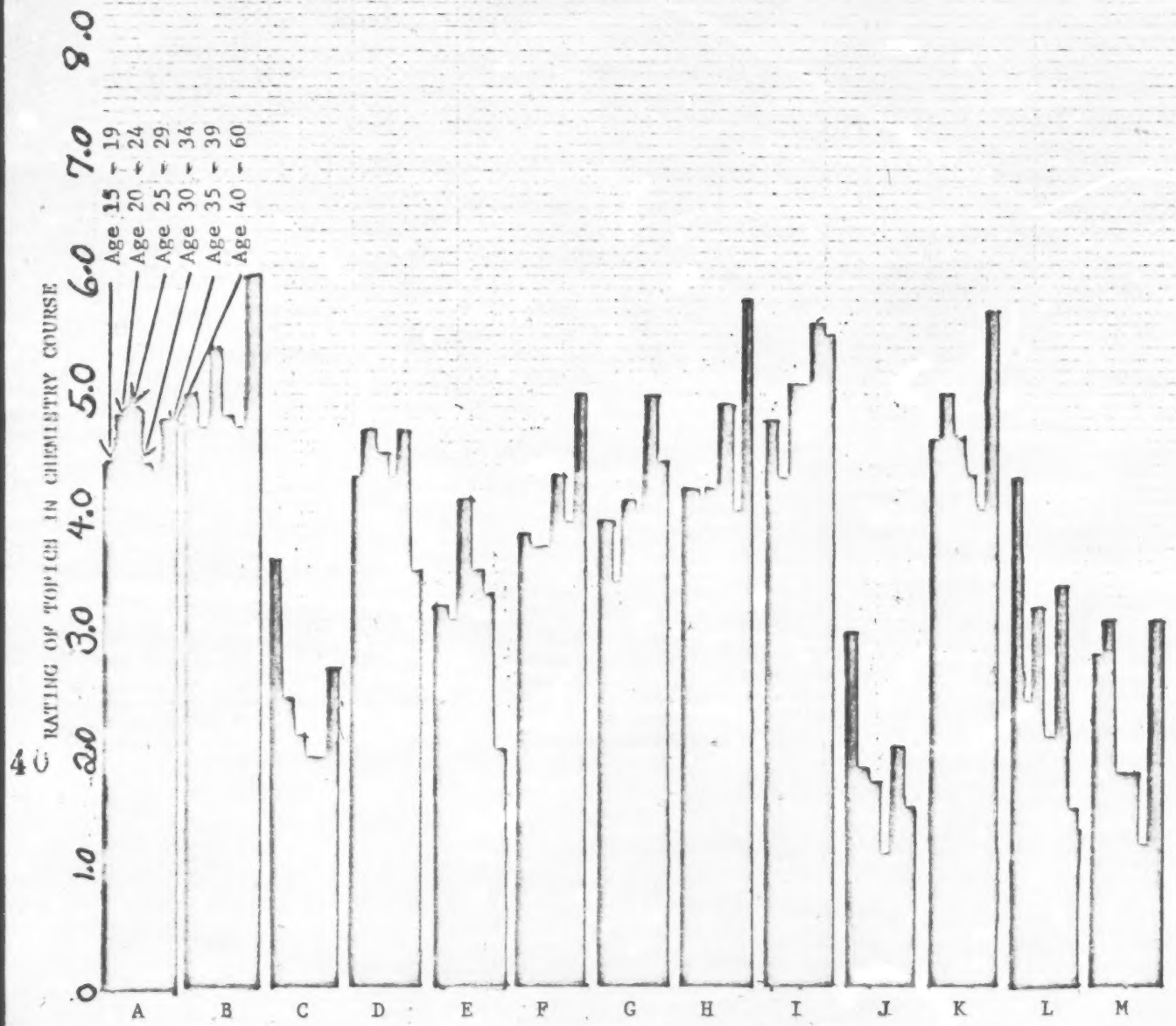


A Economy
B Energy
C Pollution
D Political Corruption
E Education
F Food Supply
G Drug Problem
H Over-population
I Systems of Government
J Mental Health
K Disease
L Abortion
M Civil Rights

Section III asks the question....."If you were to take a course in chemistry for the first time, which of the following topics would you consider the most important and should be included in the chemistry course?" This plot on the results of Section III shows that energy and pollution are considered two of the most important topics by the subjects. Figure 11 shows two other topics that are also deemed important in a chemistry course. They are the basic theory of chemistry and the chemistry of the human body. The subjects show maturity in this judgement in that they consider fundamentals of chemistry essential in a chemistry course. This would imply that the subjects are not looking for an easy course in chemistry. The high rating of the chemistry of the human body is not surprising.....most students are humans. (See Figure 11 on the following page, page 33).

FIGURE 11

Societal Topics In A Chemistry Course



A Pollution
B Energy
C Chemical Warfare
D Food Chemistry - (addition, nutrition, etc.)
E Industrial Processes (Chemical)
F Economy (effects of chemistry)
G Chemotherapy
H Drug Chemistry
I Basic Knowledge and Theories of Chemistry.
J Chemistry of fuels as related to various kinds of auto racing.
K Chemistry of the human body
L History of chemistry
M Photography

Section IV of the questionnaire shows that although the basic theories of chemistry are important, the subjects are interested in some chemical applications in their chemistry course.

TABLE 13

METHODS OF INSTRUCTION

AGE GROUPS

	1	2	3	4	5	6
A. (%)	17.9	16.1	15.5	20	8.0	18.0
B. (%)	58.9	61.3	60.0	50.0	80	54.5
C. (%)	23.0	22.5	24.4	30.0	12.0	27.0

Age Groups
- Age 1 = 15 - 19 Year
- Age 2 = 20 - 24 "
- Age 3 = 25 - 29
- Age 4 = 30 - 34
- Age 5 = 35 - 40
- Age 6 = Over 40

A = Theoretical approach with no application
B = Some theoretical and application
C = Practical application with little principles

The responses to Section VI are interesting...."If you were taking a course in general college chemistry today, which of the following teaching methods would you prefer: (See Table 14 on the next page, page 35).

TABLE 14

TEXTBOOK DESIRABILITY

		AGE GROUPS					
		1	2	3	4	5	6
A.	(%)	11.1	11.3	9.3	4.7	9.5	8.0
B.	(%)	63.8	74.2	67.4	85.7	80.5	79.0
C.	(%)	25.0	14.5	23.2	9.5	9.5	13.0

Ages 1 - 6 = age groups are the same as Table 13.
A = Textbook course
B = Textbook plus current topics from current publications.
C = Little use of textbook with much use of current topics.

Results in Table 14 indicate the least desired approach would be the "textbook" course with little or no discussion of current topics, such as pollution and energy.

The results from Section VII....."If you were taking a course in general chemistry today, which of the following lab methods would you prefer?" are very similar to those in the two previous tables, indicating the subjects prefer a lab with some principles and applications rather than one with the complete exclusion of the others.

TABLE 15

LAB METHOD DESIRABILITY

		AGE GROUPS					
		1	2	3	4	5	6
A.	(%)	15.4	21.2	18.0	4.7	10.0	9.0
B.	(%)	54.8	45.4	59.0	81.0	70.0	72.0
C.	(%)	30.7	27.3	22.7	14.3	20.0	18.0

IDENTIFICATION OF CONTENTS OF TABLE 15:

Age groups = same as Table 13
A = Lab dealing with verification of basic principles.
B = Lab dealing with verification of basic principles with chemical application.
C = Lab dealing with chemical application.

DISCUSSION

This study was made to determine what influence the societal factors, energy and pollution, have (or could have) on the teaching of college chemistry. The study was made to seek the answers to the three questions stated in the introduction. The results of the study clearly indicates that students of all ages at Central Piedmont Community College feel that energy and pollution are very critical societal problems that should be included as a part of the chemistry course. The review of literature on energy and pollution clearly brings out a need for the awareness by everyone of these critical issues that are truly important to the survival of mankind. Pollution and energy have suddenly exploded into the face of modern man and to fully understand and appreciate the meaning of pollution and energy problems, one must have a basic knowledge of chemistry. An excellent motivation for learning chemistry is provided by the inclusion of these topics in the regular chemistry courses. Chemistry is one of the most basic disciplines with respect to understanding, teaching and alleviating environmental problems, and thus, is the ideal place for the teaching of these topics. The study has shown that older students as well as the young students are concerned about these problems and all students prefer the use of up-to-date relevant problems in their courses along with the basic principles of chemistry. Students preferred the use of chemical applications in the laboratory and a non-textbook type course.

Students are very interested in environmental problems such as energy and pollution. The review of literature has shown that these problems are very real. Energy and pollution problems are most chemical by nature. Then, why should not these topics be included in the chemistry course?

One argument presented against their use is that there is a lack of up-to-date accurate information. However, the author found over two-hundred references on the topics of energy and pollution which have been used successfully in the teaching

of environmental chemistry. (Moore, Moore, 1975)

Another major argument presented against the use of such topics in the teaching of chemistry is that this will tend to "water down" the course-work. A skillfull instructor can, during a one-year course in general college chemistry, teach the basic concepts underlying our pollution and energy problem without deleting any of the basic principles of chemistry. The author has done this many times in the teaching of general chemistry at Central Piedmont Community College. (Standardized ACS exams scores support this statement). In the opinion of the author, the inclusion of these topics actually can make the course-work more concentrated if used correctly.

At a time when the interest in sciences and in the field of chemistry is declining, the science educators must take full advantage of student interest. The science educator must somehow motivate the student before he can teach the student.

RECOMMENDATIONS

All instructors of chemistry courses, especially introductory ones, should include the topics of energy and pollution as one of the underlying themes in the courses. One of the general objectives should be that after having completed the course, the students will be much more aware of energy and pollution problems that exist today.

It appears from the results of this study that these topics could best be utilized by the instructor on a day to day basis rather than teaching of one unit per course on energy and pollution as is done in some cases.

The number of ways the chemistry instructor can utilize these topics as a means of increasing interest in a chemistry course is unlimited. For example, he could assign extra credit reading projects on the topics and have some class reports. The student could be given the option of writing a research paper on some carefully selected aspect of energy or pollution in lieu of a final exam. The use of current energy and pollution articles in the local newspaper could be an excellent way to introduce these topics into a class discussion. The principle of equilibrium can be introduced and applied very successfully by using one of the many well-known ecological cycles in nature. In the study of mercury, lead, arsenic, and other elements and compounds, the chemical and physical properties could easily be related to pollution. The study of redox, heat of reaction, and hydrocarbons are ideal units to be related to energy. The author has found such things as the students recording the chemical names of all the food additives and preservatives they have eaten for a week to be a means of increasing student interest in food chemistry. A field trip to a local power plant could do wonders to increase and/or create interest in chemistry. Here the student can see both problems in operation at the same time and place. By continually relating, emphasizing and identifying the importance of these societal

problems of energy and pollution in the course, the student can see a useful "end product" in their chemistry. The author is by no means implying that basic principles of chemistry should be sacrificed for these topics, but that the application of chemical principles be made in the area of energy and pollution and that daily classroom discussion be tied-in with these topics.

Although the number and kinds of energy and pollution that exist will vary with geographical location, one should always take advantage of their local energy and pollution problems in their community, i.e., North Carolina has a very serious natural gas problem as a result of the energy crisis. What is natural gas anyway? Methane, a chemical compound upon which we depend as an energy source for both industrial and domestic use.

Administrators should be conscious of these same problems and allow the chemistry faculty ample freedom in designing and teaching of the chemistry courses. Administrators can further encourage the chemistry faculty to keep up-to-date on current energy and pollution problems by funding travel to workshops, conferences, and other professional meetings. Administrators should encourage faculty to belong to various environmental groups and given recognition to each faculty member participant.

Instructors of chemistry should constantly keep in mind that most principles of chemistry taught today have been known for many years. It is the chemical applications that are constantly changing and the teacher must keep abreast of these to stay in constant touch with student interest.

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APPENDIXES

CHEMISTRY COURSE CONTENT QUESTIONNAIRE

by

W.E. Cheek, Central Piedmont Community College

This survey deals with topics considered important in the study of college chemistry. The purpose of this questionnaire is to determine what topics (and methods of presentation) you would want included in a college chemistry course you were taking. If you have already had one or more courses in chemistry, you should answer the questions as if you were taking a course again.

Section I

(1) What field of study do you plan to major in, or what field of study have you already completed? _____
_____.

(2) Encircle the highest grade completed.

11, 12, 13, 14, 15, 16, 17, 18

(3) What is the highest degree you hold? _____.

(4) What year did you receive the degree? _____.

(5) Encircle the age-range you are in.

15 - 19 20 - 24 25 - 29 30 - 34 35 - 39 40 - 44

45 - 49 50 - 54 55 - 59

Section II

Check the correct statement about your education in chemistry.

_____ No chemistry.

_____ Completed one year of high school chemistry.
Year taken_____

_____ Completed a part of a high school chemistry course.
Year taken_____

_____ Had one quarter of college chemistry.
Year taken_____

_____ Completed two quarters or one semester of college chemistry.
Year taken_____

_____ Completed one year (two semesters or three quarters) college chemistry.
Year taken_____

_____ Completed two years of college chemistry (four semesters or six quarters).
Year taken_____

_____ Completed three years of college chemistry.
Year taken_____

_____ Completed four years of college chemistry.
Year taken_____

_____ Hold a four year degree in chemistry.
Year completed_____

_____ Hold a graduate degree in chemistry.
Year completed_____

Section III

If you were to take a course in chemistry for the first time, which of the following topics would you consider the most and the least important to you. Using the scale of 1 - 8, rank each of the items from highest to lowest with 1 being the highest and 8 the lowest.

_____ Pollution

_____ Energy

_____ Chemical Warfare

_____ Food Chemistry - (addition, nutrition, etc.)

_____ Industrial Processes (Chemical)

_____ Economy (effects of chemistry)

_____ Chemotherapy

_____ Drug Chemistry

_____ Basic Knowledge and Theories of Chemistry.

_____ Chemistry of fuels as related to various kinds of auto racing.

_____ Chemistry of the human body

_____ History of chemistry

_____ Photography

_____ Others (specify) _____

_____.

Section IV

If you were taking a course in general chemistry for the first time, which of the following approaches would you prefer?

_____ A theoretical approach with much emphasis on the basic principles of chemistry and little emphasis on practical applications of chemistry.

_____ An approach with some emphasis on basic principles, and about equal emphasis on practical applications of chemistry.

_____ An approach with little emphasis on basic principles and much emphasis on practical applications of chemistry.

Section V

Considering all of the problems facing society today, which do you consider the most critical? Please rank using the scale of 1 - 8, 1 being the most critical and 8 the least critical.

_____ Economy

_____ Energy

_____ Pollution

_____ Political Corruption

_____ Education

_____ Food Supply

_____ Drug Problem

_____ Over-population

_____ Systems of Government

_____ Mental Health

_____ Disease

_____ Abortion

_____ Civil Rights

_____ Others (specify) _____

_____.

Section VI

If you were taking a course in general college chemistry today, which of the following methods would you prefer?

_____ A course in which the textbook is rigidly followed with little discussion of current topics from newspapers, journals, and magazines.

_____ A course in which the textbook is a basic guide for the course but with considerable time spent on current topics in chemistry found in newspapers, journals, and magazines.

_____ A course in which the textbook is used only as a reference book with much emphasis placed on current chemistry topics in newspapers and journals.

Section VII

If you were taking a course in general college chemistry today, which of the following lab methods would you prefer?

_____ A lab in which the experiments deal primarily with verifying the basic principles of chemistry (with little or no emphasis on applications of chemistry). These types of experiments usually require the use of mathematics.

_____ A lab which emphasizes some principles of chemistry along with chemical applications. This type requires the use of less mathematics.

_____ A lab in which much emphasis is placed on chemical applications with little emphasis on chemical principles. This approach would require the least amount of mathematics.

Section VIII

Comments concerning the chemistry course content: _____

_____

_____

_____

_____.